REMARKS

Claims 1-62 are now presented for examination. Claims 1-3, 11-13 and 23-25 have been amended to define still more clearly what Applicants regards as their invention, in terms which distinguish over the art of record. Claims 1-3, 11-13 and 23-25 are the only independent claims.

Claim 1 has been rejected under 35 U.S.C. § 103(a) as unpatentable over U.S. Patent 5,028,967 (Yamada, et al.). With regard to Claim 1 as amended by this amendment, this rejection is respectfully traversed.

Independent Claim 1 as amended by this amendment is directed to an illuminator that illuminates an object with luminous flux emitted from a light source. The illuminator has an illumination system through which the luminous flux is projected onto the object and has plural surfaces including a surface onto a portion of which a titanium oxide film that absorbs ultraviolet light is applied.

In Applicants' view, Yamada et al. discloses an optical achromatic lens which can be used for reduction projection aligners in ultraviolet lithography constituted by (A) high-purity silica glass having a purity of 99.9% or more, or fluorine-containing, high purity silica glass having a purity of 99.9% or more and (B) silica glass containing germanium dioxide or silica glass containing germanium dioxide and boron oxide. The Yamada et al. further discloses that additives of oxides of transition elements are not suitable for achromatic lenses for ultraviolet rays and should be removed to avoid ultraviolet absorption and further, in the case of titanium as an impurity, its concentration should be 1 ppm or less.

According to the invention of Claim 1 as amended by this amendment, an ultraviolet absorbing titanium oxide film is applied onto at least a portion of a surface of an

illumination system through which luminous flux is projected. Advantageously, the ultraviolet absorbing titanium oxide film functions to prevent contaminants from adhering to elements of the illumination system.

Yamada et al. is directed to an achromatic lens for ultraviolet rays and more particularly achromatic lenses for ultraviolet rays that can transmit ultraviolet rays having a wavelength of 300 nm or less. As taught at lines 7-15 of column 2 of Yamada et al., "in the case of the lens made of synthetic silica glass containing oxides of transition elements and rare earth elements, these additives cause ultraviolet absorption, resulting in the reduction of transmittance and the generation of fluorescence. Accordingly, these additives are not suitable for achromatic lenses for ultraviolet rays, and rather should be removed." It is further taught at lines 18 to 24 of column 3 of Yamada et al., "Particularly to avoid the ultraviolet absorption, impurities such as transition elements and rare earth elements should be reduced to several hundreds of ppm or less, preferably several tens of ppm or less, and more preferably several ppm or less. For instance, in the case of titanium as an impurity, its concentration should be 1 ppm or less."

In contrast to Yamada et al. which is directed to avoiding ultraviolet absorption, it is a feature of Claim 1 that at least one of plural surfaces of an illumination system through which luminous flux passes has an ultraviolet light absorbing titanium oxide film applied thereto. Yamada et al.'s avoidance of ultraviolet absorption or only permitting 1 ppm of titanium dioxide in an achromatic lens to avoid ultraviolet absorption is directed away and contradicts the feature of an ultraviolet absorbing titanium film applied to a surface of an illumination system through which luminous flux is projected onto an object since the ultraviolet light is projected onto a film with substantially 100% ultraviolet light absorbing titanium oxide.

As set forth in M.P.E.P. § 2141.02, for an obviousness rejection, a prior art reference must be considered in its entirety i.e. as a whole including portions that would lead away from the claimed invention. Yamada et al. specifically teaches removing or limiting titanium oxide in a lens to 1 ppm in order to avoid ultraviolet absorption in an achromatic lens and fails in any way to suggest an ultraviolet absorbing titanium dioxide film on the surface of an illumination system. If one skilled in the art were to provide a film on the achromatic lens surface, Yamada et al., as a whole, directed away from including any titanium oxide that absorbs ultraviolet light in such a film and having an object of avoiding ultraviolet light absorption fails to provide any motivation for applying a such a titanium oxide film that absorbs ultraviolet to a surface of an illumination system through which luminous flux is projected onto an object as in Claim 1. It is therefore believed that Claim 1 as amended by this amendment is completely distinguished from Yamada et al. and is allowable.

Claims 2 through 62 have been rejected under 35 U.S.C. § 103(a) as unpatentable over Yamada et al. in view of U.S. Patent 5,661,546 (Taniguchi) and U.S. Patent 4,358,198 (Moriyama et al.). With regard to the claims as amended by this amendment, this rejection is respectfully traversed.

Independent Claim 2 as amended by this amendment is directed to an illuminator that illuminates an object with a luminous flux emitted from a light source. In the illuminator, an illumination system through which the luminous flux is projected onto an object has plural optical units. At least one of the plural optical units has a surface onto at least a portion of which a titanium oxide film that absorbs ultraviolet light is applied.

Independent Claim 12 as amended by this amendment is directed to exposure apparatus that exposes a wafer with a pattern formed on a mask. In the exposure apparatus, an

illumination system that illuminates the mask with light from a light source has plural optical units. At least one of the plural optical units has a surface onto at least a portion of which a titanium oxide film absorbing ultraviolet light is applied.

Independent Claim 24 as amended by this amendment is directed to a projection aligner that illuminates a pattern formed on a mask with luminous flux and projects the pattern onto a wafer. In the projection aligner, an illumination system through which the luminous flux passes has plural optical units and a projection system that projects the pattern onto the wafer has plural optical units. At least one of the plural optical units of at least one of the illumination system and the projection system has a surface onto at least a portion of which a titanium oxide film absorbing ultraviolet light is applied.

In Applicants' opinion, Taniguchi et al. discloses a projection exposure arrangement with changing image characteristics and illumination conditions wherein, while a mask is illuminated under a predetermined illumination condition to transfer the image of the pattern of the mask to a substrate, the amount of imaging characteristic change of a projection optical system is calculated using calculation parameters corresponding to the illumination condition. Imaging characteristics are adjusted based on the calculated amount. When the pattern on the mask or the illumination condition is changed, the amount of imaging characteristic change is calculated based on an amount of energy stored in the projection optical system prior to the changing of the condition. Pattern exposure is started immediately after the changing of the condition, and the imaging characteristics are adjusted based on the calculated amount.

Moriyama et al., in Applicants' view, discloses apparatus for moving a table or a stage that has movable parts adapted to be guided by guide rail means slidingly and rectilinearly.

At least the movable parts are made of a non-iron light metal material. The sliding surfaces of the movable parts making sliding contact with the guide rail means are made of a self-lubricating material, while the sliding surfaces of the guide rail means making sliding contact with the movable parts are made of a material having a higher hardness and wear resistance than the non-iron light metal material, so that the weight of at least the movable parts is reduced to decrease the weight of the apparatus as a whole.

According to the invention defined in Claims 2, 12 and 24, at least one of plural optical units of an illumination system through which luminous flux is projected onto an object has a surface onto at least a portion of which an ultraviolet light absorbing titanium dioxide film is applied. Taniguchi only teaches a projection exposure arrangement with changing image characteristics and changing illumination conditions but is devoid of any suggestion of ultraviolet light absorption by elements of an illumination system or a projection system.

As discussed with respect to Claim 1, Yamada et al. requires preventing absorption of ultraviolet light by an achromatic lens for ultraviolet light and could not possibly suggest an ultraviolet absorbing titanium oxide film applied to the surface of the achromatic lens that is adapted to transmit ultraviolet light. Taniguchi is devoid of any suggestion of an illumination system or projection system having optical unit surfaces to which an ultraviolet light absorbing titanium dioxide film is applied.

Moriyama et al. only teaches apparatus for moving a table or stage which is used for moving the specimen in a step and repeat camera, reduction projection aligner system or the like wherein aluminum, aluminum alloy, magnesium, magnesium alloy, titanium, titanium alloy is used to achieve reduction of weight but is devoid of any disclosure of an ultraviolet absorbing titanium oxide film on a surface of an optical unit. As is well known, an alloy is a homogeneous

mixture or solid solution of two or more metals, the atoms of one replacing or occupying interstitial positions between the atoms of the other and is completely different both physically and chemically from an oxide of a metal. Moriyama et al.'s use of titanium or a titanium alloy is therefore devoid of any suggestion of a titanium oxide film. Further, even if Moriyama et al. suggested a titanium or titanium alloy film, it is not seen that applying a such a titanium or titanium alloy film without the property of ultraviolet light absorption to an optical unit surface of an illumination system could possibly suggest the feature of applying an ultraviolet light absorbing titanium dioxide film to such a surface to accomplish prevention of adhering of contaminants as in the subject invention. Accordingly, there is no suggestion in Moriyama et al. of applying an ultraviolet absorbing titanium oxide film to an optical unit surface as in Claims 2, 12 and 24.

The combination of Yamada et al. and Taniguchi only suggests an achromatic lens arrangement in which ultraviolet light absorption is to be avoided by removing titanium oxide or limiting its amount to 1 ppm. Moriyama et al. only teaches the use of a titanium alloy movable parts of the guide rails of an X or Y table but fails to suggest applying a titanium oxide film to an optical unit surface of an illumination system as in the subject invention. Further, the addition of Moriyama et al.'s titanium or titanium alloy would not provide the function of titanium oxide in absorbing ultraviolet light as in the present invention. Accordingly, it is not seen that there is any motivation for combining the titanium or titanium alloy of Moriyama et al. with Yamada et al. and Taniguchi. It is also not seen that the resultant combination would suggest a desirable combination (M.P.E.P. § 2143.01). As a result, it is believed that Claims 2, 12 and 24 as amended by this amendment are completely distinguished from any combination of Yamada et al., Taniguchi and Moriyama et al. and are allowable.

Independent Claim 11 as amended by this amendment is directed to exposure apparatus that exposes a wafer with a pattern formed on a mask. In the exposure apparatus, an illumination system that illuminates the mask with light from a light source has plural surfaces including a surface onto at least a portion of which a titanium oxide film absorbing ultraviolet light is applied.

Independent Claim 23 as amended by this amendment is directed to a projection aligner that illuminates a pattern formed on a mask with luminous flux and projects the pattern onto a wafer. In the projection aligner, an illumination system passes through the luminous flux and a projection system projects the pattern onto the wafer. The illumination system and the projection system have plural surfaces including at least one surface onto at least a portion of which a titanium oxide film absorbing ultraviolet light is applied.

In accordance with the invention of Claims 11 and 23, at least one of plural surfaces of an illumination system of exposure apparatus or an illumination system and a projection system of a projection aligner has at least a portion onto which an ultraviolet light absorbing titanium dioxide film is applied. The ultraviolet light absorbing titanium dioxide film is used to prevent adherence of contaminants in the systems.

As discussed with respect to Claims 2, 12 and 24, Yamada et al. is restricted to preventing absorption of ultraviolet light in an achromatic lens for ultraviolet light. Yamada et al. only teaches removing or limiting the inclusion of titanium dioxide to 1 ppm. Applying an ultraviolet absorbing titanium oxide film to a lens surface of Yamada et al. as recited in the Claims 2, 12 and 24 could only operate to absorb the ultraviolet light rather than preventing absorption as required by Yamada et al. Taniguchi is devoid of any suggestion of an illumination system or projection system having surfaces to which an ultraviolet light absorbing

titanium dioxide film is applied. Moriyama et al. is limited to using titanium or a titanium alloy in the guide rails of an X or Y table but fails to suggest applying a titanium oxide film to an optical unit surface of an illumination system as in the subject invention. Neither titanium nor a titanium alloy in Moriyama et al. is suggested as having any property of absorbing ultraviolet light. As discussed with respect to Claims 2, 12 and 24, the addition of Moriyama et al.'s titanium or titanium alloy would not provide the function of a titanium oxide film on the surface of an illumination system or a projection system in absorbing ultraviolet light as in the present invention nor is there any suggestion that titanium or a titanium alloy could provide any absorption of ultraviolet light. Accordingly, it is not seen that there is any motivation for combining the titanium or titanium alloy rail structure of Moriyama et al. with Yamada et al. and Taniguchi or that the resultant combination would suggest a desirable combination. It is therefore believed that Claims 11 and 23 as amended by this amendment are completely distinguished from any combination of Yamada et al., Taniguchi and Moriyama et al. and are allowable

Independent Claim 3 as amended by this amendment is directed to an illuminator that illuminates an object with a luminous flux emitted from a light source. In the illuminator, an illumination system is provided through which the luminous flux is projected onto the object. The illumination system has plural optical elements and a barrel supporting the plural optical elements. The barrel has an inside surface onto at least a portion of which a titanium oxide film is applied.

Independent Claim 13 as amended by this amendment is directed to exposure apparatus that exposes a wafer with a pattern formed on a mask. In the exposure apparatus, an illumination system that illuminates the mask with light from a light source has plural optical

units. The illumination system includes plural optical elements and a barrel supporting the plural optical elements. The barrel has an inside surface onto at least a portion of which a titanium oxide film absorbing ultraviolet light is applied.

Independent Claim 25 as amended by this amendment is directed to a projection aligner that illuminates a pattern formed on a mask with luminous flux and projects the pattern onto a wafer. In the projection aligner, An illumination system through which the luminous flux is passed includes plural optical elements and a barrel that supports the plural optical elements. A projection system that projects the pattern onto the wafer includes plural optical elements and a barrel that supports the optical elements. At least one of the barrels of the illumination system and the projection system has an inside surface onto at least a portion of which a titanium oxide film absorbing ultraviolet light is applied.

It is a feature of Claims 3, 13 and 25 as amended by this amendment that a barrel supporting plural optical elements in an illumination system or in a projection optical system has an inside surface onto at least a portion of which an ultraviolet light absorbing titanium dioxide film is applied. None of Yamada et. al., Taniguchi and Moriyama et al. in any manner suggests a barrel supporting plural optical elements.

As discussed with respect to Claims 2, 12 and 24, applying an ultraviolet absorbing titanium oxide film to a lens surface of Yamada et al. as in the Claims 3, 13 and 25 does not remove or limit titanium dioxide from a lens and could only operate to absorb the ultraviolet light rather than "avoid ultraviolet light absorption" as required by Yamada et al. Taniguchi is devoid of any suggestion of an illumination system or projection system having an optical element supporting barrel with an inside surface to which an ultraviolet light absorbing titanium dioxide film is applied. Moriyama et al. is limited to using titanium or a titanium alloy

in the guide rails of an X or Y table but fails to suggest applying an ultraviolet light absorbing titanium oxide film to an optical unit surface of an illumination system as in the subject invention.

Further, even if Moriyama et al.'s titanium or titanium alloy support unit could be considered as a barrel supporting optical elements, there is no suggestion in any of the cited references that titanium or a titanium alloy could provide any ultraviolet light absorption so that it is not seen that the cited combination could possibly suggest an ultraviolet light absorbing titanium dioxide film applied to at least a portion of the inside surface of an optical element supporting barrel as in Claims 3, 13 and 25 or that the cited combination would suggest a desirable combination. Accordingly, it is believed that Claims 3, 13 and 25 are completely distinguished from any combination of Yamada et al., Taniguchi and Moriyama et al. and are allowable.

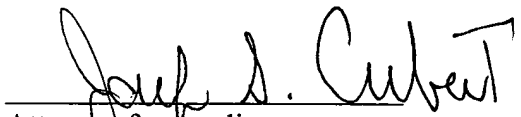
A review of the other art of record has failed to reveal anything which, in Applicants' opinion, would remedy the deficiencies of the art discussed above, as references against the independent claims herein. Those claims are therefore believed patentable over the art of record.

The other claims in this application are each dependent from one or another of the independent claims discussed above and are therefore believed patentable for the same reasons. Since each dependent claim is also deemed to define an additional aspect of the invention, however, the individual reconsideration of the patentability of each on its own merits is respectfully requested.

In view of the foregoing amendments and remarks, Applicants respectfully request favorable reconsideration and early passage to issue of the present application.

Applicant's attorney, Steven E. Warner, may be reached in our Washington, D.C. office by telephone at (202) 530-1010. All correspondence should continue to be directed to our below-listed address.

Respectfully submitted,



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VERSION WITH MARKINGS TO SHOW CHANGES MADE TO THE CLAIMS

1. (Four Times Amended) An illuminator for illuminating an object with a luminous flux emitted from a light source, said illuminator comprising:

an illumination system through which the luminous flux is projected onto the object, said illumination system having plural surfaces including a surface onto [at least] a portion of which a titanium oxide film absorbing ultraviolet light is applied.

2. (Three Times Amended) An illuminator for illuminating an object with a luminous flux emitted from a light source, said illuminator comprising:

an illumination system through which the luminous flux is projected onto the object, said illumination system including a plurality of optical units, at least one of said plurality of optical units having a surface onto at least a portion of which a titanium oxide film absorbing ultraviolet light is applied.

3. (Four Times Amended) An illuminator for illuminating an object with a luminous flux emitted from a light source, said illuminator comprising:

an illumination system through which the luminous flux is projected onto the object, said illumination system including a plurality of optical elements and a barrel for supporting said plurality of optical elements, said barrel having an inside surface onto at least a portion of which a titanium oxide film absorbing ultraviolet light is applied.

11. (Four Times Amended) An exposure apparatus for exposing a wafer with a pattern formed on a mask, said exposure apparatus comprising:

an illumination system for illuminating the mask with light from a light source,

said illumination system having plural surfaces including a surface onto at least a portion of which a titanium oxide film absorbing ultraviolet light is applied.

12. (Four Times Amended) An exposure apparatus for exposing a wafer with a pattern formed on a mask, said exposure apparatus comprising:

an illumination system for illuminating the mask with light from a light source,

said illuminating system having a plurality of optical units, at least one of said plurality of optical units having a surface onto at least a portion of which a titanium oxide film absorbing ultraviolet light is applied.

13. (Four Times Amended) An exposure apparatus for exposing a wafer with a pattern formed on a mask, said exposure apparatus comprising:

an illuminating system for illuminating the mask with light from a light source,

said illuminating system including a plurality of optical elements and a barrel for supporting said plurality of optical elements,

said barrel having an inside surface onto at least a portion of which a titanium oxide film absorbing ultraviolet light is applied.

23. (Four Times Amended) A projection aligner for illuminating a pattern formed on a mask with a luminous flux and projecting the pattern onto a wafer, said projection aligner comprising:

an illumination system through which the luminous flux is passed; and

a projection system for projecting the pattern onto the wafer,

wherein [at least one of] said illumination system and said projection system [has] have plural surfaces including [a] at least one surface onto at least a portion of which a titanium oxide film absorbing ultraviolet light is applied.

24. (Four Times Amended) A projection aligner for illuminating a pattern formed on a mask with a luminous flux and projecting the pattern onto the wafer, said projection aligner comprising:

an illumination system through which the luminous flux is passed, said illumination system including a plurality of optical units; and

a projection system for projecting the pattern onto the wafer, said projection system including a plurality of optical units,

wherein at least one of said plurality of optical units of at least one of said illumination system and said projection system has a surface onto at least a portion of which a titanium oxide film absorbing ultraviolet light is applied.

25. (Four Times Amended) A projection aligner for illuminating a pattern formed on a mask with a luminous flux and projecting the pattern onto a wafer, said projection aligner comprising:

an illumination system through which the luminous flux is passed, said illumination system including a plurality of optical elements and a barrel for supporting said plurality of optical elements; and

a projection system for projecting the pattern onto the wafer, said projection optical system including a plurality of optical elements and a barrel for supporting the plurality of optical elements,

wherein at least one of the barrels of said illumination system and said projection system has an inside surface onto at least a portion of which a titanium oxide film absorbing ultraviolet light is applied.